GENOTYPIC VARIATION IN WINTER WHEAT YIELD COMPONENTS RESPONSE TO NITROGEN MANAGEMENT AND SEEDING DENSITY

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ABSTRACT

Achieving optimal winter wheat grain yield requires understanding genotypic variations in yield component formation under nitrogen (N) application timing and seeding density management strategies. This study evaluated whether modern winter wheat genotypes exhibit differential yield formation pathways under varying N timing and seeding rate conditions, and whether reducing N rates while increasing seeding density (or vice versa) could maintain yields while reducing input costs. Additionally, we examined which yield components primarily drive productivity differences. Two winter wheat genotypes (Showdown and Butler's Gold) were examined under two N application timings (at tillering and at jointing), three seeding rates (700,000, 900,000, and 1,100,000 seeds ha^{-1}), and two N rates (60 and 120 kg N ha^{-1}) across two Oklahoma environments. Genotypes demonstrated contrasting yield formation strategies under different management scenarios. Under Tillering N application, Showdown achieved 3,790 kg ha^{-1} compared to Butler's Gold's 3,134 kg ha^{-1}, representing a 21% yield advantage *($p<0.01$)*. N application timing significantly affected yield response to seeding rate: the 700,000 and 900,000 seeding rates produced 3,694 and 3,615 kg ha^{-1}, respectively, compared to 3,077 kg ha^{-1} for 1,100,000 seeds ha^{-1} under Spring timing *($p<0.05$),* while Fall timing showed no significant seeding rate effects. Higher N rate (120 kg ha^{-1}) increased grain protein content but did not significantly improve yield over 60 kg ha^{-1}, suggesting opportunities for N rate optimization.

Showdown consistently maintained superior spike density (106.8 vs. 81.6 spikes m^{-2}) and total grain number (2,585 vs. 1,688 grains m^{-2}) compared to Butler's Gold at Tillering application *($p<0.01$).* The 700,000 seeds ha^{-1} produced 24 grains spike^{-1} compared to 21 grains spike^{-1} for 1,100,000 seeds ha^{-1} under Spring application ($p<0.01$), highlighting the density productivity trade-off. Showdown's advantage in grains per spike was consistent across timings (25.0 vs. 20.5 at Tillering; 18.5 vs. 15.8 at Jointing, $p<0.001$). Spike number showed no significant response to seeding rate, while grain weight remained relatively stable, identifying grains per spike as the critical compensatory mechanism. This study demonstrates that grains per spike emerges as the critical yield component driving genotypic differences, with Showdown's 22% advantage explaining its superior performance. The effect of N timing and seeding rate reveals that Tillering N application enables yield compensation at lower seeding densities, while N rate can be increased for protein targets rather than yield maximization. These findings establish a foundation for developing resource efficient management practices where reduced seeding rates (700,000-900,000 seeds ha^{-1}) combined with Tillering N application at 60 kg ha^{-1} optimize input costs while maximizing yield potential in modern winter wheat production systems.